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Request for Approval Vented Container Annual Release Fraction



United States
Department of Energy
Richland, Washington

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Request for Approval Vented Container Annual Release Fraction

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P.O. Box 550
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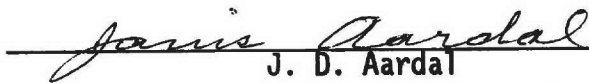
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REQUEST FOR APPROVAL VENTED CONTAINER ANNUAL RELEASE FRACTION

1.0 INTRODUCTION

In accordance with the approval conditions for *Modification to the Central Waste Complex (CWC) Radioactive Air Emissions Notice of Construction (NOC)*, dated August 24, 1998, a new release fraction has been developed for submittal to the Washington State Department of Health (WDOH). The proposed annual release fraction of 2.50 E-14 is proposed for use in future NOCs involving the storage and handling operations associated with vented containers on the Hanford Site. The proposed annual release fraction was the largest release fraction calculated from alpha measurements of the NucFil[®] filters from 10 vented containers consisting of nine 55-gallon drums and one burial box with dimensions of 9.3 x 5.7 x 6.4 feet. An annual release fraction of 2.0 E-09 was used in the modification to the CWC radioactive air emissions NOC. This study confirmed that the release fraction used in the CWC radioactive air emissions NOC was conservative.

2.0 BACKGROUND

On September 21, 1998, a meeting was held between the U.S. Department of Energy, Richland Operations Office and WDOH. Based on questions asked by WDOH, it was determined that the 222-S Laboratory Complex lowest detection limits for alpha decaying radionuclides were in the range of 0.75 to 1.5 picocuries. Detection limits for beta and gamma decaying radionuclides were in the range of 15 to 150 picocuries and 50 to 100 picocuries, respectively. Vented containers within CWC were selected based on having a high alpha radionuclide content yet still meeting the transportation and T Plant Complex radiological/criticality safety limits. In addition, all containers selected have been handled and stored for at least 3 years. Selecting vented containers with a high alpha radionuclide content and long storage times combined with the availability of low detection capabilities for alpha decay provided the best opportunity to calculate an actual annual release fraction. The equation for calculating release fractions proposed at the September 21, 1998, meeting with WDOH, was modified to include the fraction of spike actually recovered. This will result in a more accurate calculated release fraction. For conservatism, the fraction of spike material actually recovered was only used when the value was less than one. The vented container annual release fractions were calculated using the following formula:

$$RF = \frac{\frac{Count}{0.9995 \times SR}}{Inventory \times Time}$$

Where:

RF = annual release fraction
Count = NucFil filter counts (curies)
SR = fraction of spike actually recovered (accounts for method losses)
Inventory = container inventory (curies)
Time = time in storage (years)
0.9995 = minimum NucFil filter efficiency (accounts for potential escape)

® NucFil is a registered trademark of Nuclear Filter Technology, Incorporated, Golden, Colorado.

Reference: *Radioactive Air Emissions Program Notice of Construction for the Central Waste Complex and Enhance Radioactive and Mixed Waste Storage, Phase V, Project W-112*, DOE/RL-95-79, dated August 1995.

NucFil filters were prepared for sample analysis as described in a summary of the laboratory report contained within Appendix A. A spiked and a blank sample were prepared from two unused NucFil filters. The spike sample was prepared using cesium (Cs-137) and americium (Am-241). Cs-137 was selected as the gamma emitter, barium (Ba-137) a decay product of Cs-137 was the beta emitter, and Am-241 was selected as the alpha emitter.

The selected containers and the general description of the container contents are as follows.

<u>Container identification</u>	<u>General description of container contents</u>
WH-86-034 (55-gallon drum)	Metal, cement, chemicals, absorbent, plastic and 10 mil liner
BP-189055 (55-gallon drum)	Absorbent, asbestos, cloth, glass, metal, paper/cardboard, Plastic/polyurethane, and lead
BP-192018 (55-gallon drum)	10 mil liner, absorbent, glass, and metal
BP-192019 (55-gallon drum)	10 mil liner, absorbent, cloth, dirt, glass, metal, paper/cardboard, Plastic/polyurethane, and rubber
RH-A-90-005 (55-gallon drum)	Absorbent, cloth, glass, metal, paper/cardboard, Plastic/polyurethane, wood, and rubber
RH-A-92-006 (55-gallon drum)	Absorbent, cloth, and plastic
RH-A-95-012/9408762 (55-gallon drum)	Absorbent, anti-corrosive radpad, cloth, metal, plastic/polyurethane, and rubber
RH-A-95-013/9406626 (55-gallon drum)	Absorbent, anti-corrosive radpad, cloth, metal, plastic/polyurethane, and rubber
BP-189047 (55-gallon drum)	Absorbent, ceramics, glass, liquid, metal, paper/cardboard, plastic/polyurethane, and rubber
PNL-TRU-95018 (burial box)	Cloth, floor sweepings, glass, metal, paper/cardboard, plastic, rubber, and wood

Operational experience within the Central Waste Complex (e.g., frequent visual inspections and radiation surveys of the containers) has demonstrated that the containers are sound and that external contamination does not exist on the exterior of the containers. Any release of radionuclides would be through the NucFil Filters.

3.0 RESULTS AND CONCLUSIONS

Appendix B contains a summary of the results for both alpha and beta/gamma counts for each NucFil filter and the calculated annual release fraction. Because of the low sample counts, the blank was not subtracted from the actual results because many of the samples were lower than the blank, which would result in the calculation of negative annual release fractions.

For alpha decaying radionuclides, six of the sample results were reported as less-than values. For computational purposes, the number reported in the less-than value was used as the actual value for calculating an annual release fraction. Samples that were not reported as less-than values were at or above the blank value. The calculated release fractions based on alpha detection ranged from 3.23 E-15 to 2.50 E-14 . As noted in Appendix A, the 500% error associated with the count used to calculate the highest release fraction of 2.50 E-14 was attributed to the sample count being less than background.

For beta decay measurements, only one of the sample results was reported as a less-than value. For computational purposes, the number reported in the less-than value also was used as the actual value for calculating an annual release fraction. As mentioned in Appendix A, there were no gamma emitters detected. The beta/gamma numbers were reported together because the inventory within the vented containers is tracked based on the sum of the beta and gamma radionuclides. The calculated annual release fractions based on beta/gamma detection ranged from 2.33 E-11 to 6.98 E-09 .

With the exception of three samples, all of the samples were less than the blank, which suggests that the detected beta activity occurring in the blank might be from naturally occurring beta decay within the charcoal located inside the NucFil filter (e.g., carbon-14 and/or potassium-40). The release fractions calculated for the beta/gamma isotopes are unreliable and were reported only for completeness. The calculated annual release fractions are considered unreliable because of the low inventory of beta/gamma decaying radionuclides within the selected containers (1,000 to 10,000 times less than the inventory of alpha decaying radionuclides) and the presence of naturally occurring beta emitters within the charcoal located inside the NucFil filter. To obtain reliable release fractions for beta/gamma isotopes, containers with a high inventory of beta/gamma decaying radionuclides would need to be selected.

Drums with a high alpha activity were chosen over those with beta/gamma activity because a lower Practical Quantitation Limit could be achieved with alpha activity and the samples are more easily distinguished from the blank. Furthermore, a high loading of beta-gamma activity would have exposed workers to a significant radiation hazard. The annual release fraction of 2.0 E-09 used in the modification to the CWC radioactive NOC is much larger than the calculated 2.5 E-14 annual release fraction.

APPROVALS

8/15/99
9/15/99
9/15/99
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APPENDIX A

ANALYTICAL RESULTS ON TWELVE NUCFIL[®] FILTER SAMPLES RECEIVED IN JUNE 1999

ANALYTICAL RESULTS ON TWELVE NUCFIL[®] FILTER SAMPLES RECEIVED IN JUNE 1999

This appendix discusses the analytical results on twelve filter samples received on June 28, 1999. The samples were analyzed for total alpha and total beta activities, and cobalt-60, niobium-94, ruthenium/rhodium-106, antimony-125, cesium-134, cesium-137, cerium/praseodymium-144, europium-152, europium-154, europium-155, and americium-241 by gamma energy analysis (GEA). The remainder of the GEA library was also provided. A diagram indicating the sample breakdown and preparation procedures is included as Attachment 1. Tables containing all the analytical results are included at Attachment 2.

The samples were prepared and analyzed as described in the reference with one exception. The two NucFil[®] filters received as sample 221T-99-035 were not composited before sample preparation and analysis. Both of the filters in sample 221T-99-035 were prepared in the same manner as the other samples. One of the filters was analyzed for total alpha, total beta, and GEA as the blank. Alpha and beta spikes were added to the other sample following digestion to assess the efficiency of sample transfer, mounting, and counting. This sample was analyzed for total alpha and total beta activities.

Sample preparation took place as follows. The lid was removed from each sample with a handsaw. The carbon filter and silicone rubber sealant were removed with a surgical blade and placed in a beaker. The samples were ashed at approximately 550° C. There was no visible remainder of the carbon filters, although the silicone rubber survived the ashing. The beakers and silicone rubber remainders were rinsed with a nitric acid solution that was transferred into a volumetric flask for GEA. Next, the solutions were mounted for alpha and beta counting. Hence, the entire sample was used for each analysis.

No radionuclides were detected by GEA in any of the samples, however only sample 221T-99-026 had no detectable alpha or beta activity. Total alpha and total beta activities were detected in samples 221T-99-025, -032, -033, -034, and -035 (the blank). Only total beta activity was detected in samples 221T-99-027, -028, -029, -030, and -031. The highest detected total alpha activity was 1.22×10^{-6} uCi found in sample 221T-99-034. The highest detected total beta activity was 3.59×10^{-5} uCi found in sample 221T-99-030.

Each sample was counted once for total alpha and total beta and once for GEA. The total alpha, total beta, and GEA laboratory control standards were within the laboratory control limits. The total alpha and total beta spike recoveries were also within the laboratory control limits. The "spikes" were not true matrix spikes since the spikes were added to a blank as directed and not a sample. Nevertheless, the good spike recoveries indicated that there was no significant loss of activity during sample transfers and that there was no significant self-absorption of activity from solids on the sample mount.

NucFil[®] is a registered trademark of Nuclear Filter Technology, Incorporated, Golden, Colorado. The target practical quantification limits (PQLs) listed in the reference were met for all requested analyses except ruthenium/rhodium-106. The PQL for the total alpha analyses was on the order of 4×10^{-7} uCi per sample. This is equivalent to 0.4 pCi per sample. The PQL for the total beta analyses was on the order of 3 pCi per sample. The PQLs for the GEA analyses also varied slightly with the sample, and they varied with the radionuclide as well. All were less than 100 pCi per sample for the requested radionuclides except for ruthenium/rhodium-106 which was approximately 150 pCi per sample.

Included in the total alpha and total beta results are the relative percent counting errors, which are a function of sample activity, sample size, background, and counting time. The counting error represents a 95% confidence limit about a sample result. For example, the total alpha result for sample 221T-99-032 was 4.25×10^{-7} uCi with a relative counting error of 117%. Therefore, the true sample activity lies between -7.22×10^{-8} (less than background) and 9.22×10^{-7} uCi with a 95% certainty. Because these intervals are relatively large and the sample activities are very low, one should use caution when adding or subtracting results. Some samples with reported detectable amounts of activity may show no detectable amount if counted again for the same amount of time. The maximum counting error reported is 500. A counting error of 500 indicates that the sample count was less than the background.

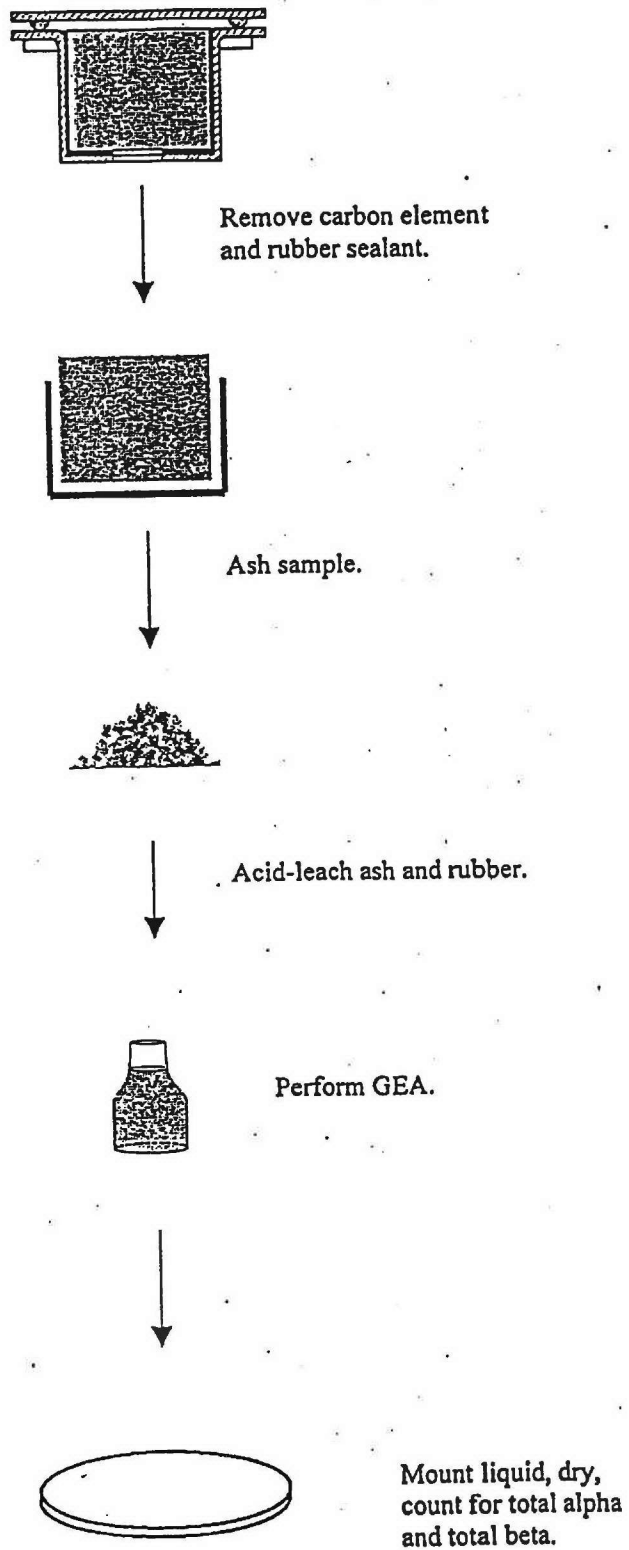
31230-99-010

ATTACHMENT 1

Sample Breakdown Diagram

Consisting of 2 pages,
Including cover page

Sample Breakdown and Analysis Scheme



31230-99-010

ATTACHMENT 2

Analytical Results

Consisting of 24 pages,
Including cover page

Customer ID: 221T-99-025
Lab Sample #: S99TP00051Sample Date : 06/09/1999 11:10
Recv. Date : 06/28/1999 09:07

PARAMETER	RESULTS	UNITS
<u>Env Alpha/Beta</u>		
Total Alpha (Each)	3.63E-07	μCi/Sample
Alpha Relative % Counting Error	1.33E+02	% Ct. Error
Total Beta (Each)	1.44E-05	μCi/Sample
Beta Relative % Counting Error	1.40E+01	% Ct. Error
<u>GEA Large Library Method</u>		
Beryllium-7	< 7.207E-05	μCi/Sample
Sodium-22	< 9.973E-06	μCi/Sample
Sodium-24	< 9.949E-06	μCi/Sample
Potassium-40	< 3.913E-04	μCi/Sample
Argon-41	< 1.535E-05	μCi/Sample
Scandium-46	< 1.467E-05	μCi/Sample
Chromium-51	< 6.484E-05	μCi/Sample
Manganese-54	< 9.256E-06	μCi/Sample
Cobalt-56	< 8.815E-06	μCi/Sample
Cobalt-57	< 5.016E-06	μCi/Sample
Cobalt-58	< 8.757E-06	μCi/Sample
Iron-59	< 1.775E-05	μCi/Sample
Cobalt-60	< 1.022E-05	μCi/Sample
Zinc-65	< 2.057E-05	μCi/Sample
Selenium-75	< 1.016E-05	μCi/Sample
Krypton-85	< 2.178E-03	μCi/Sample
Strontium-85	< 9.834E-06	μCi/Sample
Yttrium-88	< 7.617E-06	μCi/Sample
Yttrium-91	< 3.871E-03	μCi/Sample
Niobium-94	< 8.510E-06	μCi/Sample
Zirconium/Niobium-95	< 4.023E-05	μCi/Sample
Ruthenium-103	< 8.159E-06	μCi/Sample
Ruthenium/Rhodium-106	< 1.594E-04	μCi/Sample
Silver-108m	< 9.205E-06	μCi/Sample
Cadmium-109	< 1.711E-04	μCi/Sample
Silver-110m	< 8.750E-06	μCi/Sample
Tin-113	< 1.068E-05	μCi/Sample
Tellurium-123m	< 5.401E-06	μCi/Sample
Antimony-124	< 8.630E-06	μCi/Sample
Antimony-125	< 2.275E-05	μCi/Sample
Tellurium-125m	< 1.625E-03	μCi/Sample
Iodine-129	< 5.494E-03	μCi/Sample
Iodine-131	< 7.928E-06	μCi/Sample
Xenon-131m	< 2.339E-04	μCi/Sample
Barium-133	< 1.043E-05	μCi/Sample
Cesium-134	< 8.461E-06	μCi/Sample
Cesium-136	< 9.094E-06	μCi/Sample
Cesium-137	< 1.617E-05	μCi/Sample
Cesium-138	< 3.904E-05	μCi/Sample

Customer ID: 221T-99-025 (Continued)
Lab Sample #: S99TP00051

Cerium-139	< 5.648E-06	μCi/Sample
Barium-140	< 3.227E-05	μCi/Sample
Lanthanum-140	< 8.233E-06	μCi/Sample
Cerium-141	< 9.413E-06	μCi/Sample
Cerium-144	< 3.827E-05	μCi/Sample
Cerium/Praseodymium-144	< 7.646E-05	μCi/Sample
Europium-152	< 1.525E-05	μCi/Sample
Europium-154	< 2.896E-05	μCi/Sample
Europium-155	< 2.060E-05	μCi/Sample
Hafnium-181	< 9.020E-06	μCi/Sample
Tantalum-182	< 2.824E-05	μCi/Sample
Mercury-203	< 7.639E-06	μCi/Sample
Bismuth-207	< 8.102E-06	μCi/Sample
Thallium-208	< 9.773E-05	μCi/Sample
Lead-210	< 2.367E-03	μCi/Sample
Bismuth-212	< 1.397E-04	μCi/Sample
Lead-212	< 1.468E-05	μCi/Sample
Bismuth-214	< 2.713E-05	μCi/Sample
Lead-214	< 9.012E-05	μCi/Sample
Radium-224	< 1.549E-04	μCi/Sample
Radium-226	< 1.476E-04	μCi/Sample
Actinium-228	< 5.123E-05	μCi/Sample
Thorium-228	< 5.574E-04	μCi/Sample
Thorium-229	< 2.464E-05	μCi/Sample
Uranium-232	< 1.160E-02	μCi/Sample
Protactinium-233	< 1.642E-05	μCi/Sample
Uranium/Thorium-233	< 5.082E-03	μCi/Sample
Protactinium-234m	< 1.515E-03	μCi/Sample
Thorium-234	< 3.968E-04	μCi/Sample
Uranium-235	< 9.005E-06	μCi/Sample
Neptunium-237	< 5.465E-05	μCi/Sample
Uranium-237	< 1.877E-05	μCi/Sample
Neptunium-238	< 3.350E-05	μCi/Sample
Neptunium-239	< 2.103E-05	μCi/Sample
Plutonium-239	< 6.989E-02	μCi/Sample
Americium-241	< 5.575E-05	μCi/Sample
Americium-243	< 1.648E-05	μCi/Sample

Customer ID: 221T-99-026
Lab Sample #: S99TP00052Sample Date : 06/09/1999 11:11
Recv. Date : 06/28/1999 09:07

PARAMETER	RESULTS	UNITS
<u>Env Alpha/Beta</u>		
Total Alpha (Each)	< 6.21E-07	uCi/Sample
Alpha Relative % Counting Error	1.89E+02	% Ct. Error
Total Beta (Each)	< 1.80E-06	uCi/Sample
Beta Relative % Counting Error	2.64E+02	% Ct. Error
<u>GEA Large Library Method</u>		
Beryllium-7	< 7.310E-05	μCi/Sample
Sodium-22	< 9.839E-06	μCi/Sample
Sodium-24	< 9.125E-06	μCi/Sample
Potassium-40	< 3.927E-04	μCi/Sample
Argon-41	< 1.450E-05	μCi/Sample
Scandium-46	< 1.313E-05	μCi/Sample
Chromium-51	< 6.359E-05	μCi/Sample
Manganese-54	< 9.715E-06	μCi/Sample
Cobalt-56	< 8.954E-06	μCi/Sample
Cobalt-57	< 5.112E-06	μCi/Sample
Cobalt-58	< 8.545E-06	μCi/Sample
Iron-59	< 1.831E-05	μCi/Sample
Cobalt-60	< 1.011E-05	μCi/Sample
Zinc-65	< 2.180E-05	μCi/Sample
Selenium-75	< 1.016E-05	μCi/Sample
Krypton-85	< 2.128E-03	μCi/Sample
Strontium-85	< 9.604E-06	μCi/Sample
Yttrium-88	< 7.679E-06	μCi/Sample
Yttrium-91	< 3.822E-03	μCi/Sample
Niobium-94	< 9.202E-06	μCi/Sample
Zirconium/Niobium-95	< 3.865E-05	μCi/Sample
Ruthenium-103	< 8.369E-06	μCi/Sample
Ruthenium/Rhodium-106	< 1.588E-04	μCi/Sample
Silver-108m	< 9.205E-06	μCi/Sample
Cadmium-109	< 1.683E-04	μCi/Sample
Silver-110m	< 8.202E-06	μCi/Sample
Tin-113	< 1.084E-05	μCi/Sample
Tellurium-123m	< 5.364E-06	μCi/Sample
Antimony-124	< 8.043E-06	μCi/Sample
Antimony-125	< 2.446E-05	μCi/Sample
Tellurium-125m	< 1.619E-03	μCi/Sample
Iodine-129	< 5.711E-03	μCi/Sample
Iodine-131	< 8.354E-06	μCi/Sample
Xenon-131m	< 2.420E-04	μCi/Sample
Barium-133	< 1.067E-05	μCi/Sample
Cesium-134	< 7.896E-06	μCi/Sample
Cesium-136	< 8.716E-06	μCi/Sample
Cesium-137	< 1.447E-05	μCi/Sample
Cesium-138	< 4.036E-05	μCi/Sample

Customer ID: 221T-99-026 (Continued)
Lab Sample #: S99TP00052

Cerium-139	< 5.814E-06	μCi/Sample
Barium-140	< 3.028E-05	μCi/Sample
Lanthanum-140	< 9.040E-06	μCi/Sample
Cerium-141	< 9.392E-06	μCi/Sample
Cerium-144	< 3.945E-05	μCi/Sample
Cerium/Praseodymium-144	< 7.882E-05	μCi/Sample
Europium-152	< 1.547E-05	μCi/Sample
Europium-154	< 2.858E-05	μCi/Sample
Europium-155	< 1.984E-05	μCi/Sample
Hafnium-181	< 9.405E-06	μCi/Sample
Tantalum-182	< 2.854E-05	μCi/Sample
Mercury-203	< 7.513E-06	μCi/Sample
Bismuth-207	< 7.958E-06	μCi/Sample
Thallium-208	< 9.632E-05	μCi/Sample
Lead-210	< 2.311E-03	μCi/Sample
Bismuth-212	< 1.403E-04	μCi/Sample
Lead-212	< 1.491E-05	μCi/Sample
Bismuth-214	< 2.728E-05	μCi/Sample
Lead-214	< 9.188E-05	μCi/Sample
Radium-224	< 1.517E-04	μCi/Sample
Radium-226	< 1.440E-04	μCi/Sample
Actinium-228	< 4.953E-05	μCi/Sample
Thorium-228	< 5.565E-04	μCi/Sample
Thorium-229	< 2.418E-05	μCi/Sample
Uranium-232	< 1.133E-02	μCi/Sample
Protactinium-233	< 1.664E-05	μCi/Sample
Uranium/Thorium-233	< 5.340E-03	μCi/Sample
Protactinium-234m	< 1.591E-03	μCi/Sample
Thorium-234	< 3.995E-04	μCi/Sample
Uranium-235	< 8.840E-06	μCi/Sample
Neptunium-237	< 5.275E-05	μCi/Sample
Uranium-237	< 1.920E-05	μCi/Sample
Neptunium-238	< 3.503E-05	μCi/Sample
Neptunium-239	< 2.070E-05	μCi/Sample
Plutonium-239	< 7.025E-02	μCi/Sample
Americium-241	< 5.453E-05	μCi/Sample
Americium-243	< 1.591E-05	μCi/Sample

Customer ID: 221T-99-027
Lab Sample #: S99TP00053Sample Date : 06/09/1999 11:13
Recv. Date : 06/28/1999 09:07

PARAMETER	RESULTS	UNITS
<u>Env Alpha/Beta</u>		
Total Alpha (Each)	< 5.46E-07	uCi/Sample
Alpha Relative % Counting Error	2.45E+02	% Ct. Error
Total Beta (Each)	1.85E-06	uCi/Sample
Beta Relative % Counting Error	8.29E+01	% Ct. Error
<u>GEA Large Library Method</u>		
Beryllium-7	< 7.115E-05	μCi/Sample
Sodium-22	< 9.728E-06	μCi/Sample
Sodium-24	< 8.519E-06	μCi/Sample
Potassium-40	< 3.849E-04	μCi/Sample
Argon-41	< 1.542E-05	μCi/Sample
Scandium-46	< 1.381E-05	μCi/Sample
Chromium-51	< 6.366E-05	μCi/Sample
Manganese-54	< 9.796E-06	μCi/Sample
Cobalt-56	< 8.928E-06	μCi/Sample
Cobalt-57	< 5.107E-06	μCi/Sample
Cobalt-58	< 8.606E-06	μCi/Sample
Iron-59	< 1.872E-05	μCi/Sample
Cobalt-60	< 1.006E-05	μCi/Sample
Zinc-65	< 2.052E-05	μCi/Sample
Selenium-75	< 1.035E-05	μCi/Sample
Krypton-85	< 2.102E-03	μCi/Sample
Strontium-85	< 9.494E-06	μCi/Sample
Yttrium-88	< 7.168E-06	μCi/Sample
Yttrium-91	< 3.867E-03	μCi/Sample
Niobium-94	< 8.636E-06	μCi/Sample
Zirconium/Niobium-95	< 3.863E-05	μCi/Sample
Ruthenium-103	< 8.611E-06	μCi/Sample
Ruthenium/Rhodium-106	< 1.590E-04	μCi/Sample
Silver-108m	< 9.122E-06	μCi/Sample
Cadmium-109	< 1.676E-04	μCi/Sample
Silver-110m	< 8.530E-06	μCi/Sample
Tin-113	< 1.067E-05	μCi/Sample
Tellurium-123m	< 5.490E-06	μCi/Sample
Antimony-124	< 8.061E-06	μCi/Sample
Antimony-125	< 2.336E-05	μCi/Sample
Tellurium-125m	< 1.624E-03	μCi/Sample
Iodine-129	< 5.612E-03	μCi/Sample
Iodine-131	< 8.147E-06	μCi/Sample
Xenon-131m	< 2.378E-04	μCi/Sample
Barium-133	< 1.060E-05	μCi/Sample
Cesium-134	< 8.286E-06	μCi/Sample
Cesium-136	< 8.647E-06	μCi/Sample
Cesium-137	< 1.482E-05	μCi/Sample
Cesium-138	< 3.890E-05	μCi/Sample

Customer ID: 221T-99-027 (Continued)
Lab Sample #: S99TP00053

Cerium-139	< 5.834E-06	μCi/Sample
Barium-140	< 3.210E-05	μCi/Sample
Lanthanum-140	< 8.389E-06	μCi/Sample
Cerium-141	< 9.268E-06	μCi/Sample
Cerium-144	< 3.849E-05	μCi/Sample
Cerium/Praseodymium-144	< 7.691E-05	μCi/Sample
Europium-152	< 1.543E-05	μCi/Sample
Europium-154	< 2.827E-05	μCi/Sample
Europium-155	< 1.937E-05	μCi/Sample
Hafnium-181	< 9.527E-06	μCi/Sample
Tantalum-182	< 2.770E-05	μCi/Sample
Mercury-203	< 7.327E-06	μCi/Sample
Bismuth-207	< 8.078E-06	μCi/Sample
Thallium-208	< 9.299E-05	μCi/Sample
Lead-210	< 2.289E-03	μCi/Sample
Bismuth-212	< 1.395E-04	μCi/Sample
Lead-212	< 1.502E-05	μCi/Sample
Bismuth-214	< 2.662E-05	μCi/Sample
Lead-214	< 8.863E-05	μCi/Sample
Radium-224	< 1.544E-04	μCi/Sample
Radium-226	< 1.472E-04	μCi/Sample
Actinium-228	< 4.818E-05	μCi/Sample
Thorium-228	< 5.660E-04	μCi/Sample
Thorium-229	< 2.420E-05	μCi/Sample
Uranium-232	< 1.163E-02	μCi/Sample
Protactinium-233	< 1.616E-05	μCi/Sample
Uranium/Thorium-233	< 5.148E-03	μCi/Sample
Protactinium-234m	< 1.633E-03	μCi/Sample
Thorium-234	< 3.934E-04	μCi/Sample
Uranium-235	< 8.986E-06	μCi/Sample
Neptunium-237	< 5.149E-05	μCi/Sample
Uranium-237	< 1.937E-05	μCi/Sample
Neptunium-238	< 3.342E-05	μCi/Sample
Neptunium-239	< 2.015E-05	μCi/Sample
Plutonium-239	< 6.885E-02	μCi/Sample
Americium-241	< 5.642E-05	μCi/Sample
Americium-243	< 1.635E-05	μCi/Sample

Customer ID: 221T-99-028
Lab Sample #: S99TP00054Sample Date : 06/09/1999 11:15
Recv. Date : 06/28/1999 09:07

PARAMETER	RESULTS	UNITS
<u>Env Alpha/Beta</u>		
Total Alpha (Each)	< 6.21E-07	uCi/Sample
Alpha Relative % Counting Error	1.89E+02	% Ct. Error
Total Beta (Each)	1.78E-06	uCi/Sample
Beta Relative % Counting Error	8.60E+01	% Ct. Error
<u>GEA Large Library Method</u>		
Beryllium-7	< 7.253E-05	μCi/Sample
Sodium-22	< 9.829E-06	μCi/Sample
Sodium-24	< 9.368E-06	μCi/Sample
Potassium-40	< 3.796E-04	μCi/Sample
Argon-41	< 1.547E-05	μCi/Sample
Scandium-46	< 1.337E-05	μCi/Sample
Chromium-51	< 6.120E-05	μCi/Sample
Manganese-54	< 9.578E-06	μCi/Sample
Cobalt-56	< 9.072E-06	μCi/Sample
Cobalt-57	< 5.092E-06	μCi/Sample
Cobalt-58	< 8.375E-06	μCi/Sample
Iron-59	< 1.780E-05	μCi/Sample
Cobalt-60	< 9.104E-06	μCi/Sample
Zinc-65	< 2.107E-05	μCi/Sample
Selenium-75	< 1.039E-05	μCi/Sample
Krypton-85	< 2.113E-03	μCi/Sample
Strontium-85	< 9.537E-06	μCi/Sample
Yttrium-88	< 8.774E-06	μCi/Sample
Yttrium-91	< 3.690E-03	μCi/Sample
Niobium-94	< 8.595E-06	μCi/Sample
Zirconium/Niobium-95	< 3.871E-05	μCi/Sample
Ruthenium-103	< 8.049E-06	μCi/Sample
Ruthenium/Rhodium-106	< 1.641E-04	μCi/Sample
Silver-108m	< 9.017E-06	μCi/Sample
Cadmium-109	< 1.673E-04	μCi/Sample
Silver-110m	< 9.014E-06	μCi/Sample
Tin-113	< 1.062E-05	μCi/Sample
Tellurium-123m	< 5.410E-06	μCi/Sample
Antimony-124	< 8.218E-06	μCi/Sample
Antimony-125	< 2.450E-05	μCi/Sample
Tellurium-125m	< 1.631E-03	μCi/Sample
Iodine-129	< 5.544E-03	μCi/Sample
Iodine-131	< 8.247E-06	μCi/Sample
Xenon-131m	< 2.387E-04	μCi/Sample
Barium-133	< 1.083E-05	μCi/Sample
Cesium-134	< 8.411E-06	μCi/Sample
Cesium-136	< 8.457E-06	μCi/Sample
Cesium-137	< 1.469E-05	μCi/Sample
Cesium-138	< 3.966E-05	μCi/Sample

Customer ID: 221T-99-028 (Continued)
Lab Sample #: S99TP00054

Cerium-139	< 5.932E-06	μCi/Sample
Barium-140	< 3.070E-05	μCi/Sample
Lanthanum-140	< 8.780E-06	μCi/Sample
Cerium-141	< 9.287E-06	μCi/Sample
Cerium-144	< 3.970E-05	μCi/Sample
Cerium/Praseodymium-144	< 7.933E-05	μCi/Sample
Europium-152	< 1.545E-05	μCi/Sample
Europium-154	< 2.858E-05	μCi/Sample
Europium-155	< 1.980E-05	μCi/Sample
Hafnium-181	< 9.321E-06	μCi/Sample
Tantalum-182	< 2.799E-05	μCi/Sample
Mercury-203	< 7.414E-06	μCi/Sample
Bismuth-207	< 8.057E-06	μCi/Sample
Thallium-208	< 9.671E-05	μCi/Sample
Lead-210	< 2.225E-03	μCi/Sample
Bismuth-212	< 1.457E-04	μCi/Sample
Lead-212	< 1.469E-05	μCi/Sample
Bismuth-214	< 2.660E-05	μCi/Sample
Lead-214	< 8.730E-05	μCi/Sample
Radium-224	< 1.503E-04	μCi/Sample
Radium-226	< 1.458E-04	μCi/Sample
Actinium-228	< 5.046E-05	μCi/Sample
Thorium-228	< 5.624E-04	μCi/Sample
Thorium-229	< 2.409E-05	μCi/Sample
Uranium-232	< 1.117E-02	μCi/Sample
Protactinium-233	< 1.617E-05	μCi/Sample
Uranium/Thorium-233	< 5.255E-03	μCi/Sample
Protactinium-234m	< 1.456E-03	μCi/Sample
Thorium-234	< 4.035E-04	μCi/Sample
Uranium-235	< 8.855E-06	μCi/Sample
Neptunium-237	< 5.258E-05	μCi/Sample
Uranium-237	< 1.919E-05	μCi/Sample
Neptunium-238	< 3.362E-05	μCi/Sample
Neptunium-239	< 2.050E-05	μCi/Sample
Plutonium-239	< 6.890E-02	μCi/Sample
Americium-241	< 5.643E-05	μCi/Sample
Americium-243	< 1.517E-05	μCi/Sample

Customer ID: 221T-99-029
Lab Sample #: S99TP00055Sample Date : 06/10/1999 10:03
Recv. Date : 06/28/1999 09:07

PARAMETER	RESULTS	UNITS
<u>Env Alpha/Beta</u>		
Total Alpha (Each)	< 3.24E-07	uCi/Sample
Alpha Relative % Counting Error	5.00E+02	% Ct. Error
Total Beta (Each)	3.36E-06	uCi/Sample
Beta Relative % Counting Error	4.77E+01	% Ct. Error
<u>GEA Large Library Method</u>		
Beryllium-7	< 6.815E-05	μCi/Sample
Sodium-22	< 9.986E-06	μCi/Sample
Sodium-24	< 9.327E-06	μCi/Sample
Potassium-40	< 3.810E-04	μCi/Sample
Argon-41	< 1.584E-05	μCi/Sample
Scandium-46	< 1.340E-05	μCi/Sample
Chromium-51	< 6.355E-05	μCi/Sample
Manganese-54	< 8.830E-06	μCi/Sample
Cobalt-56	< 8.804E-06	μCi/Sample
Cobalt-57	< 5.065E-06	μCi/Sample
Cobalt-58	< 8.831E-06	μCi/Sample
Iron-59	< 1.777E-05	μCi/Sample
Cobalt-60	< 9.971E-06	μCi/Sample
Zinc-65	< 1.971E-05	μCi/Sample
Selenium-75	< 1.001E-05	μCi/Sample
Krypton-85	< 2.081E-03	μCi/Sample
Strontium-85	< 9.393E-06	μCi/Sample
Yttrium-88	< 7.585E-06	μCi/Sample
Yttrium-91	< 3.714E-03	μCi/Sample
Niobium-94	< 8.859E-06	μCi/Sample
Zirconium/Niobium-95	< 3.769E-05	μCi/Sample
Ruthenium-103	< 8.251E-06	μCi/Sample
Ruthenium/Rhodium-106	< 1.578E-04	μCi/Sample
Silver-108m	< 8.898E-06	μCi/Sample
Cadmium-109	< 1.671E-04	μCi/Sample
Silver-110m	< 8.831E-06	μCi/Sample
Tin-113	< 1.093E-05	μCi/Sample
Tellurium-123m	< 5.336E-06	μCi/Sample
Antimony-124	< 8.269E-06	μCi/Sample
Antimony-125	< 2.363E-05	μCi/Sample
Tellurium-125m	< 1.593E-03	μCi/Sample
Iodine-129	< 5.601E-03	μCi/Sample
Iodine-131	< 8.075E-06	μCi/Sample
Xenon-131m	< 2.315E-04	μCi/Sample
Barium-133	< 1.069E-05	μCi/Sample
Cesium-134	< 8.084E-06	μCi/Sample
Cesium-136	< 8.744E-06	μCi/Sample
Cesium-137	< 1.457E-05	μCi/Sample
Cesium-138	< 3.903E-05	μCi/Sample

Customer ID: 221T-99-029 (Continued)
Lab Sample #: S99TP00055

Cerium-139	< 5.630E-06	μCi/Sample
Barium-140	< 3.208E-05	μCi/Sample
Lanthanum-140	< 8.497E-06	μCi/Sample
Cerium-141	< 9.015E-06	μCi/Sample
Cerium-144	< 3.923E-05	μCi/Sample
Cerium/Praseodymium-144	< 7.838E-05	μCi/Sample
Europium-152	< 1.522E-05	μCi/Sample
Europium-154	< 2.900E-05	μCi/Sample
Europium-155	< 1.984E-05	μCi/Sample
Hafnium-181	< 8.915E-06	μCi/Sample
Tantalum-182	< 2.805E-05	μCi/Sample
Mercury-203	< 7.554E-06	μCi/Sample
Bismuth-207	< 7.820E-06	μCi/Sample
Thallium-208	< 9.693E-05	μCi/Sample
Lead-210	< 2.304E-03	μCi/Sample
Bismuth-212	< 1.431E-04	μCi/Sample
Lead-212	< 1.454E-05	μCi/Sample
Bismuth-214	< 2.610E-05	μCi/Sample
Lead-214	< 8.818E-05	μCi/Sample
Radium-224	< 1.540E-04	μCi/Sample
Radium-226	< 1.496E-04	μCi/Sample
Actinium-228	< 5.151E-05	μCi/Sample
Thorium-228	< 5.504E-04	μCi/Sample
Thorium-229	< 2.418E-05	μCi/Sample
Uranium-232	< 1.136E-02	μCi/Sample
Protactinium-233	< 1.640E-05	μCi/Sample
Uranium/Thorium-233	< 5.168E-03	μCi/Sample
Protactinium-234m	< 1.451E-03	μCi/Sample
Thorium-234	< 4.033E-04	μCi/Sample
Uranium-235	< 8.999E-06	μCi/Sample
Neptunium-237	< 5.277E-05	μCi/Sample
Uranium-237	< 1.834E-05	μCi/Sample
Neptunium-238	< 3.615E-05	μCi/Sample
Neptunium-239	< 2.014E-05	μCi/Sample
Plutonium-239	< 6.698E-02	μCi/Sample
Americium-241	< 5.529E-05	μCi/Sample
Americium-243	< 1.614E-05	μCi/Sample

Customer ID: 221T-99-030
Lab Sample #: S99TP00056Sample Date : 06/10/1999 11:15
Recv. Date : 06/28/1999 09:07

PARAMETER	RESULTS	UNITS
<u>Env Alpha/Beta</u>		
Total Alpha (Each)	< 5.46E-07	uCi/Sample
Alpha Relative % Counting Error	2.45E+02	% Ct. Error
Total Beta (Each)	3.59E-05	uCi/Sample
Beta Relative % Counting Error	7.33E+00	% Ct. Error
<u>GEA Large Library Method</u>		
Beryllium-7	< 7.177E-05	μCi/Sample
Sodium-22	< 1.026E-05	μCi/Sample
Sodium-24	< 9.197E-06	μCi/Sample
Potassium-40	< 3.921E-04	μCi/Sample
Argon-41	< 1.458E-05	μCi/Sample
Scandium-46	< 1.370E-05	μCi/Sample
Chromium-51	< 6.484E-05	μCi/Sample
Manganese-54	< 8.980E-06	μCi/Sample
Cobalt-56	< 9.167E-06	μCi/Sample
Cobalt-57	< 5.031E-06	μCi/Sample
Cobalt-58	< 8.894E-06	μCi/Sample
Iron-59	< 1.837E-05	μCi/Sample
Cobalt-60	< 9.923E-06	μCi/Sample
Zinc-65	< 2.046E-05	μCi/Sample
Selenium-75	< 9.859E-06	μCi/Sample
Krypton-85	< 2.116E-03	μCi/Sample
Strontium-85	< 9.549E-06	μCi/Sample
Yttrium-88	< 8.118E-06	μCi/Sample
Yttrium-91	< 3.916E-03	μCi/Sample
Niobium-94	< 9.527E-06	μCi/Sample
Zirconium/Niobium-95	< 3.586E-05	μCi/Sample
Ruthenium-103	< 8.275E-06	μCi/Sample
Ruthenium/Rhodium-106	< 1.609E-04	μCi/Sample
Silver-108m	< 8.853E-06	μCi/Sample
Cadmium-109	< 1.699E-04	μCi/Sample
Silver-110m	< 8.333E-06	μCi/Sample
Tin-113	< 1.081E-05	μCi/Sample
Tellurium-123m	< 5.327E-06	μCi/Sample
Antimony-124	< 7.837E-06	μCi/Sample
Antimony-125	< 2.411E-05	μCi/Sample
Tellurium-125m	< 1.652E-03	μCi/Sample
Iodine-129	< 5.364E-03	μCi/Sample
Iodine-131	< 8.224E-06	μCi/Sample
Xenon-131m	< 2.349E-04	μCi/Sample
Barium-133	< 1.062E-05	μCi/Sample
Cesium-134	< 7.874E-06	μCi/Sample
Cesium-136	< 8.863E-06	μCi/Sample
Cesium-137	< 3.957E-05	μCi/Sample
Cesium-138	< 5.723E-06	μCi/Sample

Customer ID: 221T-99-030 (Continued)
Lab Sample #: S99TP00056

Cerium-139	< 3.096E-05	μCi/Sample
Barium-140	< 8.631E-06	μCi/Sample
Lanthanum-140	< 9.241E-06	μCi/Sample
Cerium-141	< 3.885E-05	μCi/Sample
Cerium-144	< 7.764E-05	μCi/Sample
Cerium/Praseodymium-144	< 1.529E-05	μCi/Sample
Europium-152	< 2.978E-05	μCi/Sample
Europium-154	< 1.977E-05	μCi/Sample
Europium-155	< 9.250E-06	μCi/Sample
Hafnium-181	< 2.772E-05	μCi/Sample
Tantalum-182	< 7.531E-06	μCi/Sample
Mercury-203	< 7.578E-06	μCi/Sample
Bismuth-207	< 9.609E-05	μCi/Sample
Thallium-208	< 9.609E-05	μCi/Sample
Lead-210	< 2.252E-03	μCi/Sample
Bismuth-212	< 1.347E-04	μCi/Sample
Lead-212	< 1.500E-05	μCi/Sample
Bismuth-214	< 2.554E-05	μCi/Sample
Lead-214	< 8.914E-05	μCi/Sample
Radium-224	< 1.538E-04	μCi/Sample
Radium-226	< 1.448E-04	μCi/Sample
Actinium-228	< 4.943E-05	μCi/Sample
Thorium-228	< 5.452E-04	μCi/Sample
Thorium-229	< 2.475E-05	μCi/Sample
Uranium-232	< 1.122E-02	μCi/Sample
Protactinium-233	< 1.623E-05	μCi/Sample
Uranium/Thorium-233	< 5.428E-03	μCi/Sample
Protactinium-234m	< 1.568E-03	μCi/Sample
Thorium-234	< 4.028E-04	μCi/Sample
Uranium-235	< 8.813E-06	μCi/Sample
Neptunium-237	< 5.262E-05	μCi/Sample
Uranium-237	< 1.927E-05	μCi/Sample
Neptunium-238	< 3.561E-05	μCi/Sample
Neptunium-239	< 2.037E-05	μCi/Sample
Plutonium-239	< 6.804E-02	μCi/Sample
Americium-241	< 5.501E-05	μCi/Sample
Americium-243	< 1.603E-05	μCi/Sample

Customer ID: 221T-99-031
Lab Sample #: S99TP00057Sample Date : 06/10/1999 13:10
Recv. Date : 06/28/1999 09:07

PARAMETER	RESULTS	UNITS
<u>Env Alpha/Beta</u>		
Total Alpha (Each)	< 3.24E-07	uCi/Sample
Alpha Relative % Counting Error	5.00E+02	% Ct. Error
Total Beta (Each)	1.89E-06	uCi/Sample
Beta Relative % Counting Error	8.15E+01	% Ct. Error
<u>GEA Large Library Method</u>		
Beryllium-7	< 7.148E-05	μCi/Sample
Sodium-22	< 1.022E-05	μCi/Sample
Sodium-24	< 8.795E-06	μCi/Sample
Potassium-40	< 3.868E-04	μCi/Sample
Argon-41	< 1.649E-05	μCi/Sample
Scandium-46	< 1.361E-05	μCi/Sample
Chromium-51	< 6.573E-05	μCi/Sample
Manganese-54	< 9.155E-06	μCi/Sample
Cobalt-56	< 8.751E-06	μCi/Sample
Cobalt-57	< 5.143E-06	μCi/Sample
Cobalt-58	< 8.987E-06	μCi/Sample
Iron-59	< 1.781E-05	μCi/Sample
Cobalt-60	< 1.011E-05	μCi/Sample
Zinc-65	< 2.067E-05	μCi/Sample
Selenium-75	< 9.995E-06	μCi/Sample
Krypton-85	< 2.108E-03	μCi/Sample
Strontium-85	< 9.509E-06	μCi/Sample
Yttrium-88	< 7.233E-06	μCi/Sample
Yttrium-91	< 3.693E-03	μCi/Sample
Niobium-94	< 8.892E-06	μCi/Sample
Zirconium/Niobium-95	< 3.880E-05	μCi/Sample
Ruthenium-103	< 8.086E-06	μCi/Sample
Ruthenium/Rhodium-106	< 1.567E-04	μCi/Sample
Silver-108m	< 9.356E-06	μCi/Sample
Cadmium-109	< 1.639E-04	μCi/Sample
Silver-110m	< 8.490E-06	μCi/Sample
Tin-113	< 1.045E-05	μCi/Sample
Tellurium-123m	< 5.263E-06	μCi/Sample
Antimony-124	< 8.304E-06	μCi/Sample
Antimony-125	< 2.389E-05	μCi/Sample
Tellurium-125m	< 1.633E-03	μCi/Sample
Iodine-129	< 5.434E-03	μCi/Sample
Iodine-131	< 8.219E-06	μCi/Sample
Xenon-131m	< 2.252E-04	μCi/Sample
Barium-133	< 1.079E-05	μCi/Sample
Cesium-134	< 7.903E-06	μCi/Sample
Cesium-136	< 8.875E-06	μCi/Sample
Cesium-137	< 1.431E-05	μCi/Sample
Cesium-138	< 4.293E-05	μCi/Sample

Customer ID: 221T-99-031 (Continued)

Lab Sample #: S99TP00057

Cerium-139	< 5.482E-06	μCi/Sample
Barium-140	< 3.150E-05	μCi/Sample
Lanthanum-140	< 7.542E-06	μCi/Sample
Cerium-141	< 9.042E-06	μCi/Sample
Cerium-144	< 3.880E-05	μCi/Sample
Cerium/Praseodymium-144	< 7.753E-05	μCi/Sample
Europium-152	< 1.565E-05	μCi/Sample
Europium-154	< 2.970E-05	μCi/Sample
Europium-155	< 1.963E-05	μCi/Sample
Hafnium-181	< 9.201E-06	μCi/Sample
Tantalum-182	< 2.761E-05	μCi/Sample
Mercury-203	< 7.595E-06	μCi/Sample
Bismuth-207	< 8.228E-06	μCi/Sample
Thallium-208	< 9.773E-05	μCi/Sample
Lead-210	< 2.261E-03	μCi/Sample
Bismuth-212	< 1.383E-04	μCi/Sample
Lead-212	< 1.450E-05	μCi/Sample
Bismuth-214	< 2.593E-05	μCi/Sample
Lead-214	< 8.682E-05	μCi/Sample
Radium-224	< 1.512E-04	μCi/Sample
Radium-226	< 1.441E-04	μCi/Sample
Actinium-228	< 4.942E-05	μCi/Sample
Thorium-228	< 5.484E-04	μCi/Sample
Thorium-229	< 2.364E-05	μCi/Sample
Uranium-232	< 1.131E-02	μCi/Sample
Protactinium-233	< 1.586E-05	μCi/Sample
Uranium/Thorium-233	< 5.189E-03	μCi/Sample
Protactinium-234m	< 1.496E-03	μCi/Sample
Thorium-234	< 3.992E-04	μCi/Sample
Uranium-235	< 8.743E-06	μCi/Sample
Neptunium-237	< 5.228E-05	μCi/Sample
Uranium-237	< 1.867E-05	μCi/Sample
Neptunium-238	< 3.494E-05	μCi/Sample
Neptunium-239	< 1.999E-05	μCi/Sample
Plutonium-239	< 6.662E-02	μCi/Sample
Americium-241	< 5.485E-05	μCi/Sample
Americium-243	< 1.606E-05	μCi/Sample

Customer ID: 221T-99-032
Lab Sample #: S99TP00058Sample Date : 06/10/1999 14:40
Recv. Date : 06/28/1999 09:07

PARAMETER	RESULTS	UNITS
<u>Env Alpha/Beta</u>		
Total Alpha (Each)	4.25E-07	uCi/Sample
Alpha Relative % Counting Error	1.17E+02	% Ct. Error
Total Beta (Each)	9.79E-06	uCi/Sample
Beta Relative % Counting Error	1.89E+01	% Ct. Error
<u>GEA Large Library Method</u>		
Beryllium-7	< 6.946E-05	μCi/Sample
Sodium-22	< 1.071E-05	μCi/Sample
Sodium-24	< 9.425E-06	μCi/Sample
Potassium-40	< 3.860E-04	μCi/Sample
Argon-41	< 1.488E-05	μCi/Sample
Scandium-46	< 1.392E-05	μCi/Sample
Chromium-51	< 6.325E-05	μCi/Sample
Manganese-54	< 9.286E-06	μCi/Sample
Cobalt-56	< 9.100E-06	μCi/Sample
Cobalt-57	< 4.971E-06	μCi/Sample
Cobalt-58	< 8.316E-06	μCi/Sample
Iron-59	< 1.940E-05	μCi/Sample
Cobalt-60	< 9.670E-06	μCi/Sample
Zinc-65	< 2.014E-05	μCi/Sample
Selenium-75	< 9.851E-06	μCi/Sample
Krypton-85	< 2.120E-03	μCi/Sample
Strontium-85	< 9.569E-06	μCi/Sample
Yttrium-88	< 8.459E-06	μCi/Sample
Yttrium-91	< 3.586E-03	μCi/Sample
Niobium-94	< 8.643E-06	μCi/Sample
Zirconium/Niobium-95	< 3.801E-05	μCi/Sample
Ruthenium-103	< 7.908E-06	μCi/Sample
Ruthenium/Rhodium-106	< 1.624E-04	μCi/Sample
Silver-108m	< 9.520E-06	μCi/Sample
Cadmium-109	< 1.656E-04	μCi/Sample
Silver-110m	< 8.757E-06	μCi/Sample
Tin-113	< 1.065E-05	μCi/Sample
Tellurium-123m	< 5.358E-06	μCi/Sample
Antimony-124	< 8.296E-06	μCi/Sample
Antimony-125	< 2.351E-05	μCi/Sample
Tellurium-125m	< 1.595E-03	μCi/Sample
Iodine-129	< 5.402E-03	μCi/Sample
Iodine-131	< 8.243E-06	μCi/Sample
Xenon-131m	< 2.338E-04	μCi/Sample
Barium-133	< 1.057E-05	μCi/Sample
Cesium-134	< 8.358E-06	μCi/Sample
Cesium-136	< 8.252E-06	μCi/Sample
Cesium-137	< 1.476E-05	μCi/Sample
Cesium-138	< 3.793E-05	μCi/Sample

Customer ID: 221T-99-032 (Continued)
Lab Sample #: S99TP00058

Cerium-139	< 5.642E-06	μCi/Sample
Barium-140	< 3.197E-05	μCi/Sample
Lanthanum-140	< 8.730E-06	μCi/Sample
Cerium-141	< 9.405E-06	μCi/Sample
Cerium-144	< 3.891E-05	μCi/Sample
Cerium/Praseodymium-144	< 7.774E-05	μCi/Sample
Europium-152	< 1.505E-05	μCi/Sample
Europium-154	< 3.113E-05	μCi/Sample
Europium-155	< 1.963E-05	μCi/Sample
Hafnium-181	< 9.385E-06	μCi/Sample
Tantalum-182	< 2.840E-05	μCi/Sample
Mercury-203	< 7.301E-06	μCi/Sample
Bismuth-207	< 8.281E-06	μCi/Sample
Thallium-208	< 9.707E-05	μCi/Sample
Lead-210	< 2.326E-03	μCi/Sample
Bismuth-212	< 1.402E-04	μCi/Sample
Lead-212	< 1.477E-05	μCi/Sample
Bismuth-214	< 2.662E-05	μCi/Sample
Lead-214	< 8.688E-05	μCi/Sample
Radium-224	< 1.519E-04	μCi/Sample
Radium-226	< 1.482E-04	μCi/Sample
Actinium-228	< 5.162E-05	μCi/Sample
Thorium-228	< 5.449E-04	μCi/Sample
Thorium-229	< 2.372E-05	μCi/Sample
Uranium-232	< 1.141E-02	μCi/Sample
Protactinium-233	< 1.659E-05	μCi/Sample
Uranium/Thorium-233	< 5.294E-03	μCi/Sample
Protactinium-234m	< 1.526E-03	μCi/Sample
Thorium-234	< 3.977E-04	μCi/Sample
Uranium-235	< 9.040E-06	μCi/Sample
Neptunium-237	< 5.223E-05	μCi/Sample
Uranium-237	< 1.840E-05	μCi/Sample
Neptunium-238	< 3.410E-05	μCi/Sample
Neptunium-239	< 2.075E-05	μCi/Sample
Plutonium-239	< 6.872E-02	μCi/Sample
Americium-241	< 5.502E-05	μCi/Sample
Americium-243	< 1.613E-05	μCi/Sample

Customer ID: 221T-99-033
Lab Sample #: S99TP00059Sample Date : 06/10/1999 11:00
Recv. Date : 06/28/1999 09:07

PARAMETER	RESULTS	UNITS
<u>Env Alpha/Beta</u>		
Total Alpha (Each)	8.55E-07	uCi/Sample
Alpha Relative % Counting Error	6.92E+01	% Ct. Error
Total Beta (Each)	2.90E-06	uCi/Sample
Beta Relative % Counting Error	5.45E+01	% Ct. Error
<u>GEA Large Library Method</u>		
Beryllium-7	< 7.149E-05	μCi/Sample
Sodium-22	< 1.032E-05	μCi/Sample
Sodium-24	< 9.780E-06	μCi/Sample
Potassium-40	< 3.867E-04	μCi/Sample
Argon-41	< 1.546E-05	μCi/Sample
Scandium-46	< 1.343E-05	μCi/Sample
Chromium-51	< 6.299E-05	μCi/Sample
Manganese-54	< 8.694E-06	μCi/Sample
Cobalt-56	< 8.917E-06	μCi/Sample
Cobalt-57	< 5.050E-06	μCi/Sample
Cobalt-58	< 8.547E-06	μCi/Sample
Iron-59	< 1.806E-05	μCi/Sample
Cobalt-60	< 9.698E-06	μCi/Sample
Zinc-65	< 1.950E-05	μCi/Sample
Selenium-75	< 9.846E-06	μCi/Sample
Krypton-85	< 2.099E-03	μCi/Sample
Strontium-85	< 9.475E-06	μCi/Sample
Yttrium-88	< 7.386E-06	μCi/Sample
Yttrium-91	< 3.646E-03	μCi/Sample
Niobium-94	< 8.681E-06	μCi/Sample
Zirconium/Niobium-95	< 3.923E-05	μCi/Sample
Ruthenium-103	< 8.076E-06	μCi/Sample
Ruthenium/Rhodium-106	< 1.585E-04	μCi/Sample
Silver-108m	< 9.508E-06	μCi/Sample
Cadmium-109	< 1.657E-04	μCi/Sample
Silver-110m	< 8.809E-06	μCi/Sample
Tin-113	< 1.083E-05	μCi/Sample
Tellurium-123m	< 5.412E-06	μCi/Sample
Antimony-124	< 7.923E-06	μCi/Sample
Antimony-125	< 2.444E-05	μCi/Sample
Tellurium-125m	< 1.581E-03	μCi/Sample
Iodine-129	< 5.278E-03	μCi/Sample
Iodine-131	< 8.338E-06	μCi/Sample
Xenon-131m	< 2.366E-04	μCi/Sample
Barium-133	< 1.030E-05	μCi/Sample
Cesium-134	< 7.937E-06	μCi/Sample
Cesium-136	< 8.306E-06	μCi/Sample
Cesium-137	< 1.453E-05	μCi/Sample
Cesium-138	< 3.839E-05	μCi/Sample

Customer ID: 221T-99-033 (Continued)
Lab Sample #: S99TP00059

Cerium-139	< 5.675E-06	μCi/Sample
Barium-140	< 3.203E-05	μCi/Sample
Lanthanum-140	< 9.214E-06	μCi/Sample
Cerium-141	< 9.257E-06	μCi/Sample
Cerium-144	< 3.911E-05	μCi/Sample
Cerium/Praseodymium-144	< 7.813E-05	μCi/Sample
Europium-152	< 1.533E-05	μCi/Sample
Europium-154	< 2.999E-05	μCi/Sample
Europium-155	< 1.931E-05	μCi/Sample
Hafnium-181	< 9.175E-06	μCi/Sample
Tantalum-182	< 2.894E-05	μCi/Sample
Mercury-203	< 7.618E-06	μCi/Sample
Bismuth-207	< 8.207E-06	μCi/Sample
Thallium-208	< 9.697E-05	μCi/Sample
Lead-210	< 2.243E-03	μCi/Sample
Bismuth-212	< 1.385E-04	μCi/Sample
Lead-212	< 1.484E-05	μCi/Sample
Bismuth-214	< 2.682E-05	μCi/Sample
Lead-214	< 9.036E-05	μCi/Sample
Radium-224	< 1.559E-04	μCi/Sample
Radium-226	< 1.485E-04	μCi/Sample
Actinium-228	< 4.972E-05	μCi/Sample
Thorium-228	< 5.509E-04	μCi/Sample
Thorium-229	< 2.398E-05	μCi/Sample
Uranium-232	< 1.112E-02	μCi/Sample
Protactinium-233	< 1.607E-05	μCi/Sample
Uranium/Thorium-233	< 5.263E-03	μCi/Sample
Protactinium-234m	< 1.563E-03	μCi/Sample
Thorium-234	< 4.023E-04	μCi/Sample
Uranium-235	< 8.937E-06	μCi/Sample
Neptunium-237	< 5.132E-05	μCi/Sample
Uranium-237	< 1.871E-05	μCi/Sample
Neptunium-238	< 3.476E-05	μCi/Sample
Neptunium-239	< 1.969E-05	μCi/Sample
Plutonium-239	< 6.688E-02	μCi/Sample
Americium-241	< 5.492E-05	μCi/Sample
Americium-243	< 1.590E-05	μCi/Sample

Customer ID: 221T-99-034
Lab Sample #: S99TP00060Sample Date : 06/24/1999 15:30
Recv. Date : 06/28/1999 09:07

PARAMETER	RESULTS	UNITS
<u>Env Alpha/Beta</u>		
Total Alpha (Each)	1.22E-06	uCi/Sample
Alpha Relative % Counting Error	5.40E+01	% Ct. Error
Total Beta (Each)	9.19E-06	uCi/Sample
Beta Relative % Counting Error	1.99E+01	% Ct. Error
<u>GEA Large Library Method</u>		
Beryllium-7	< 7.185E-05	μCi/Sample
Sodium-22	< 1.064E-05	μCi/Sample
Sodium-24	< 9.310E-06	μCi/Sample
Potassium-40	< 3.852E-04	μCi/Sample
Argon-41	< 1.516E-05	μCi/Sample
Scandium-46	< 1.368E-05	μCi/Sample
Chromium-51	< 6.396E-05	μCi/Sample
Manganese-54	< 9.028E-06	μCi/Sample
Cobalt-56	< 9.553E-06	μCi/Sample
Cobalt-57	< 5.060E-06	μCi/Sample
Cobalt-58	< 8.400E-06	μCi/Sample
Iron-59	< 1.771E-05	μCi/Sample
Cobalt-60	< 9.083E-06	μCi/Sample
Zinc-65	< 2.056E-05	μCi/Sample
Selenium-75	< 9.819E-06	μCi/Sample
Krypton-85	< 2.059E-03	μCi/Sample
Strontium-85	< 9.292E-06	μCi/Sample
Yttrium-88	< 7.445E-06	μCi/Sample
Yttrium-91	< 3.740E-03	μCi/Sample
Niobium-94	< 9.247E-06	μCi/Sample
Zirconium/Niobium-95	< 3.799E-05	μCi/Sample
Ruthenium-103	< 8.040E-06	μCi/Sample
Ruthenium/Rhodium-106	< 1.577E-04	μCi/Sample
Silver-108m	< 8.899E-06	μCi/Sample
Cadmium-109	< 1.635E-04	μCi/Sample
Silver-110m	< 8.503E-06	μCi/Sample
Tin-113	< 1.091E-05	μCi/Sample
Tellurium-123m	< 5.411E-06	μCi/Sample
Antimony-124	< 7.847E-06	μCi/Sample
Antimony-125	< 2.366E-05	μCi/Sample
Tellurium-125m	< 1.564E-03	μCi/Sample
Iodine-129	< 5.359E-03	μCi/Sample
Iodine-131	< 8.091E-06	μCi/Sample
Xenon-131m	< 2.343E-04	μCi/Sample
Barium-133	< 1.053E-05	μCi/Sample
Cesium-134	< 8.028E-06	μCi/Sample
Cesium-136	< 8.977E-06	μCi/Sample
Cesium-137	< 1.451E-05	μCi/Sample
Cesium-138	< 4.086E-05	μCi/Sample

Customer ID: 221T-99-034 (Continued)
Lab Sample #: S99TP00060

Cerium-139	< 5.696E-06	μCi/Sample
Barium-140	< 3.121E-05	μCi/Sample
Lanthanum-140	< 8.777E-06	μCi/Sample
Cerium-141	< 9.154E-06	μCi/Sample
Cerium-144	< 4.004E-05	μCi/Sample
Cerium/Praseodymium-144	< 8.002E-05	μCi/Sample
Europium-152	< 1.532E-05	μCi/Sample
Europium-154	< 3.095E-05	μCi/Sample
Europium-155	< 1.903E-05	μCi/Sample
Hafnium-181	< 9.101E-06	μCi/Sample
Tantalum-182	< 2.843E-05	μCi/Sample
Mercury-203	< 7.307E-06	μCi/Sample
Bismuth-207	< 8.062E-06	μCi/Sample
Thallium-208	< 9.518E-05	μCi/Sample
Lead-210	< 2.223E-03	μCi/Sample
Bismuth-212	< 1.419E-04	μCi/Sample
Lead-212	< 1.474E-05	μCi/Sample
Bismuth-214	< 2.589E-05	μCi/Sample
Lead-214	< 8.537E-05	μCi/Sample
Radium-224	< 1.529E-04	μCi/Sample
Radium-226	< 1.447E-04	μCi/Sample
Actinium-228	< 4.872E-05	μCi/Sample
Thorium-228	< 5.374E-04	μCi/Sample
Thorium-229	< 2.370E-05	μCi/Sample
Uranium-232	< 1.074E-02	μCi/Sample
Protactinium-233	< 1.629E-05	μCi/Sample
Uranium/Thorium-233	< 5.180E-03	μCi/Sample
Protactinium-234m	< 1.509E-03	μCi/Sample
Thorium-234	< 3.987E-04	μCi/Sample
Uranium-235	< 8.820E-06	μCi/Sample
Neptunium-237	< 5.049E-05	μCi/Sample
Uranium-237	< 1.856E-05	μCi/Sample
Neptunium-238	< 3.333E-05	μCi/Sample
Neptunium-239	< 2.013E-05	μCi/Sample
Plutonium-239	< 6.892E-02	μCi/Sample
Americium-241	< 5.533E-05	μCi/Sample
Americium-243	< 1.612E-05	μCi/Sample

Customer ID: 221T-99-035 BLANK
Lab Sample #: N/ASample Date : 06/24/1999 11:00
Recv. Date : 06/28/1999 09:07

PARAMETER	RESULTS	UNITS
<u>Env Alpha/Beta</u>		
Total Alpha (Each)	3.63E-07	μCi/Sample
Alpha Relative % Counting Error	1.33E+02	% Ct. Error
Total Beta (Each)	4.47E-06	μCi/Sample
Beta Relative % Counting Error	3.68E+01	% Ct. Error
<u>GEA Large Library Method</u>		
Beryllium-7	< 7.392E-05	μCi/Sample
Sodium-22	< 1.052E-05	μCi/Sample
Sodium-24	< 9.921E-06	μCi/Sample
Potassium-40	< 3.875E-04	μCi/Sample
Argon-41	< 1.508E-05	μCi/Sample
Scandium-46	< 1.393E-05	μCi/Sample
Chromium-51	< 6.388E-05	μCi/Sample
Manganese-54	< 8.594E-06	μCi/Sample
Cobalt-56	< 9.156E-06	μCi/Sample
Cobalt-57	< 5.148E-06	μCi/Sample
Cobalt-58	< 8.859E-06	μCi/Sample
Iron-59	< 1.863E-05	μCi/Sample
Cobalt-60	< 9.746E-06	μCi/Sample
Zinc-65	< 2.132E-05	μCi/Sample
Selenium-75	< 1.004E-05	μCi/Sample
Krypton-85	< 2.043E-03	μCi/Sample
Strontium-85	< 9.217E-06	μCi/Sample
Yttrium-88	< 7.753E-06	μCi/Sample
Yttrium-91	< 3.796E-03	μCi/Sample
Niobium-94	< 9.026E-06	μCi/Sample
Zirconium/Niobium-95	< 4.115E-05	μCi/Sample
Ruthenium-103	< 8.343E-06	μCi/Sample
Ruthenium/Rhodium-106	< 1.538E-04	μCi/Sample
Silver-108m	< 9.133E-06	μCi/Sample
Cadmium-109	< 1.682E-04	μCi/Sample
Silver-110m	< 8.491E-06	μCi/Sample
Tin-113	< 1.065E-05	μCi/Sample
Tellurium-123m	< 5.423E-06	μCi/Sample
Antimony-124	< 8.370E-06	μCi/Sample
Antimony-125	< 2.443E-05	μCi/Sample
Tellurium-125m	< 1.627E-03	μCi/Sample
Iodine-129	< 5.629E-03	μCi/Sample
Iodine-131	< 8.551E-06	μCi/Sample
Xenon-131m	< 2.371E-04	μCi/Sample
Barium-133	< 1.042E-05	μCi/Sample
Cesium-134	< 8.479E-06	μCi/Sample
Cesium-136	< 9.043E-06	μCi/Sample
Cesium-137	< 1.483E-05	μCi/Sample
Cesium-138	< 3.762E-05	μCi/Sample

Customer ID: 221T-99-035 BLANK (Continued)
Lab Sample #: N/A

Cerium-139	< 5.828E-06	μCi/Sample
Barium-140	< 3.184E-05	μCi/Sample
Lanthanum-140	< 8.906E-06	μCi/Sample
Cerium-141	< 8.988E-06	μCi/Sample
Cerium-144	< 3.960E-05	μCi/Sample
Cerium/Praseodymium-144	< 7.913E-05	μCi/Sample
Europium-152	< 1.576E-05	μCi/Sample
Europium-154	< 3.057E-05	μCi/Sample
Europium-155	< 1.955E-05	μCi/Sample
Hafnium-181	< 9.038E-06	μCi/Sample
Tantalum-182	< 2.809E-05	μCi/Sample
Mercury-203	< 7.418E-06	μCi/Sample
Bismuth-207	< 8.026E-06	μCi/Sample
Thallium-208	< 9.687E-05	μCi/Sample
Lead-210	< 2.371E-03	μCi/Sample
Bismuth-212	< 1.498E-04	μCi/Sample
Lead-212	< 1.485E-05	μCi/Sample
Bismuth-214	< 2.758E-05	μCi/Sample
Lead-214	< 9.469E-05	μCi/Sample
Radium-224	< 1.549E-04	μCi/Sample
Radium-226	< 1.454E-04	μCi/Sample
Actinium-228	< 5.063E-05	μCi/Sample
Thorium-228	< 5.543E-04	μCi/Sample
Thorium-229	< 2.429E-05	μCi/Sample
Uranium-232	< 1.145E-02	μCi/Sample
Protactinium-233	< 1.670E-05	μCi/Sample
Uranium/Thorium-233	< 5.110E-03	μCi/Sample
Protactinium-234m	< 1.546E-03	μCi/Sample
Thorium-234	< 4.021E-04	μCi/Sample
Uranium-235	< 8.902E-06	μCi/Sample
Neptunium-237	< 5.204E-05	μCi/Sample
Uranium-237	< 1.942E-05	μCi/Sample
Neptunium-238	< 3.416E-05	μCi/Sample
Neptunium-239	< 2.071E-05	μCi/Sample
Plutonium-239	< 6.766E-02	μCi/Sample
Americium-241	< 5.559E-05	μCi/Sample
Americium-243	< 1.643E-05	μCi/Sample

Customer ID: 221T-99-035 SPIKE
Lab Sample #: S99TP00062

Sample Date : 06/24/1999 11:00
Recv. Date : 06/28/1999 09:07

PARAMETER	RESULTS	UNITS
Env Alpha/Beta		
Total Alpha (Each)	3.36E-03	uCi/Sample
Alpha Relative % Counting Error	8.39E-01	% Ct. Error
Total Beta (Each)	1.39E-02	uCi/Sample
Beta Relative % Counting Error	3.11E-01	% Ct. Error
Calculated Spike Recoveries*		
Total Alpha	88.2	% Recovery
Total Beta	103.6	% Recovery

*Spike added to the sample digest

APPENDIX B

CALCULATED RELEASE FRACTIONS

ALPHA RESULTS									
BLANK	3.63E-07	uCi							
SPIKE	3.36E-03	uCi							
SPIKE RECOVERY	88.2%								
NUCFIL EFFICIENCY	99.95%								
CONTAINER ID	SAMPLE NUMBER	PACKAGE DATE	NUCFIL REMOVAL DATE	TIME DIFFERENCE, YEARS	ALPHA CURIES IN CONTAINER	LABORATORY COUNT (uCi/Sample)	% COUNT ERROR	ADJUSTED LABORATORY COUNT TO ACCOUNT FOR RECOVERY (uCi/Sample)	CALCULATED ANNUAL RELEASE FRACTION (1/YR)
WH-86-034	221T-99-025	3/2/93	6/9/99	6.27	12.9	3.63E-07	133%	4.12E-07	5.09E-15
BP-189055 *	221T-99-026	9/13/91	6/9/99	7.74	18.9	6.21E-07	189%	7.04E-07	4.82E-15
BP-192018 *	221T-99-027	12/18/92	6/9/99	6.47	10.5	5.46E-07	245%	6.19E-07	9.11E-15
BP-192019 *	221T-99-028	3/5/93	6/9/99	6.26	10.1	6.21E-07	189%	7.04E-07	1.11E-14
RH-A-90-005 *	221T-99-029	4/25/90	6/10/99	9.13	12.3	3.24E-07	500%	3.67E-07	3.27E-15
RH-A-92-006 *	221T-99-030	7/15/92	6/10/99	6.90	10.8	5.46E-07	245%	6.19E-07	8.31E-15
RH-A-95-012/9408762 *	221T-99-031	4/25/95	6/10/99	4.13	11.9	3.24E-07	500%	3.67E-07	7.49E-15
RH-A-95-013/9406629	221T-99-032	8/9/95	6/10/99	3.84	10.8	4.25E-07	117%	4.82E-07	1.16E-14
BP-189047	221T-99-033	9/3/91	6/10/99	7.77	38.7	8.55E-07	69.2%	9.69E-07	3.23E-15
PNL-TRU-95018	221T-99-034	2/7/94	6/24/99	5.37	10.3	1.22E-06	540%	1.38E-06	2.50E-14
								LARGEST VALUE	2.50E-14
BETA/GAMMA RESULTS									
BLANK	4.47E-06	uCi							
SPIKE	1.39E-02	uCi							
SPIKE RECOVERY	103.6%	(USED 100% IN CALCULATIONS)							
NUCFIL EFFICIENCY	99.95%								
CONTAINER ID	SAMPLE NUMBER	PACKAGE DATE	NUCFIL REMOVAL DATE	TIME DIFFERENCE, YEARS	TOTAL BETA/GAMMA CURIES IN CONTAINER	LABORATORY COUNT (uCi/Sample)	% COUNT ERROR	ADJUSTED LABORATORY COUNT TO ACCOUNT FOR RECOVERY (uCi/Sample)	CALCULATED ANNUAL RELEASE FRACTION (1/YR)
WH-86-034	221T-99-025	3/2/93	6/9/99	6.27	2.000E-03	1.44E-05	14.0%	1.44E-05	1.15E-09
BP-189055 *	221T-99-026	9/13/91	6/9/99	7.74	1.000E-02	1.80E-06	264.0%	1.80E-06	2.33E-11
BP-192018	221T-99-027	12/18/92	6/9/99	6.47	4.100E-05	1.85E-06	82.9%	1.85E-06	6.98E-09
BP-192019	221T-99-028	3/5/93	6/9/99	6.26	5.000E-04	1.78E-06	86.0%	1.78E-06	5.69E-10
RH-A-90-005	221T-99-029	4/25/90	6/10/99	9.13	1.600E-03	3.36E-06	47.7%	3.36E-06	2.30E-10
RH-A-92-006	221T-99-030	7/15/92	6/10/99	6.90	2.000E-02	3.59E-05	7.33%	3.59E-05	2.60E-10
RH-A-95-012/9408762	221T-99-031	4/25/95	6/10/99	4.13	5.000E-03	1.89E-06	81.5%	1.89E-06	9.17E-11
RH-A-95-013/9406629	221T-99-032	8/9/95	6/10/99	3.84	3.500E-02	9.79E-06	18.9%	9.79E-06	7.30E-11
BP-189047	221T-99-033	9/3/91	6/10/99	7.77	9.225E-03	2.90E-06	54.5%	2.90E-06	4.05E-11
PNL-TRU-95018	221T-99-034	2/7/94	6/24/99	5.37	6.827E-02	9.19E-06	19.9%	9.19E-06	2.51E-11
								LARGEST VALUE	6.98E-09
NOTES:									
	1 YEAR = 365.25 DAYS								
	* = LESS THAN VALUE REPORTED								
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